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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: William J. Schaff et al.

Title: AlN COATED HETEROJUNCTION FIELD EFFECT TRANSISTOR AND METHOD OF FORMING AN AlN COATING

Docket No.: 1153.044US1
Filed: May 15, 2001
Examiner: Khanh B. Duong

Serial No.: 09/858,337
Due Date: August 3, 2004
Group Art Unit: 2822

Appeal Brief -- Patent
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

We are transmitting herewith the following attached items (as indicated with an "X"):

X A return postcard.
X Appellants' Brief on Appeal including Appendix I (14 pgs.) in triplicate.

If not provided for in a separate paper filed herewith, Please consider this a PETITION FOR EXTENSION OF TIME for sufficient number of months to enter these papers and please charge any additional fees or credit overpayment to Deposit Account No. 19-0743.

SCHWEGMAN, LUNDBERG, WOESSNER & KLUTH, P.A.
Customer Number 21186

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Atty: David W. Black
Reg. No. 42,331

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Dawn M. Poole
Name

[signature]
Signature

SCHWEGMAN, LUNDBERG, WOESSNER & KLUTH, P.A.
(GENERAL)

PATENT

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In re Application of:		)	
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APPELLANTS' BRIEF ON APPEAL

Mail Stop Appeal Brief- Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

The Appeal Brief is presented in support of the Notice of Appeal to the Board of Patent Appeals and Interferences, filed on June 3, 2004, from the Final Rejection of claims 1-19 of the above-identified application, as set forth in the Final Office Action mailed on June 3, 2004.

This Appeal Brief is filed in triplicate. The Commissioner of Patents and Trademarks is hereby authorized to charge Deposit Account No. 19-0743 in the amount of 165.00 which represents the requisite fee set forth in 37 C.F.R. § 117. The Appellants respectfully request consideration and reversal of the Examiner's rejections of pending claims.

APPELLANTS' BRIEF ON APPEAL

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1. REAL PARTY IN INTEREST

The real party in interest of the above-captioned patent application is the assignee, CORNELL RESEARCH FOUNDATION, INC..

2. RELATED APPEALS AND INTERFERENCES

There are no other appeals or interferences known to Appellant that will have a bearing on the Board's decision in the present appeal.

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Claims 1-19 are pending in the application and have all been finally rejected. The rejected claims 1-19 are the subject of the present appeal.

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No amendments have been made subsequent to the Final Office Action mailed to the Appellants on December 3, 2003.

5. SUMMARY OF THE INVENTION

A process for forming an AlN surface passivation layer 32 on an hetrojunction field effect transistor (HFET). As discussed in the background, large bandwidth amplifiers are typically created by taking a high power narrow band amplifier design and making it broadband by sacrificing power for bandwidth. The AlN passivation layer of the present invention allows increased power output in these circumstances. In the example described at page 4, lines 4-6, the AlN passivation layer approximately doubled the output power of HFETs in the 8 GHz range and increased the RF output current from 400mA/mm to 800mA/mm.

The AlN passivation layer in one embodiment is formed over the entire device wafer following the deposition and patterning of the interconnect metal, as shown in Figure 6 and described at page 7, lines 20-26. The deposition may be formed using molecular beam epitaxy, sputtering, or any other method which produces an approximately conformal coverage of the surface of the HFET. The deposition is preformed at approximately 150°C using alternating beams of aluminum and remote plasma RF nitrogen as discussed at page 8, lines 14-28. HFETs with the AlN passivation layer described in the current invention are useful in a wide range of products, including microwave generated plasma lights, microwave transmitters, receivers and cellular base stations to name a few.

6. ISSUES PRESENTED FOR REVIEW

1. Whether claim 1 is patentable under 35 USC § 102(b) over Huang et al. (U.S. Patent No. 5,719,088).

2. Whether claims 2, 5 and 9 are patentable under 35 USC § 103(a) over Huang et al. in view of Yoshida (U.S. Patent No. 6,281,099).

3. Whether claims 3-4 are patentable under 35 USC § 103(a) over Huang et al. in view of Kato et al. (U.S. Patent No. 6,069,020).

4. Whether claims 6-8 and 10-19 are patentable under 35 USC § 103(a) over Huang et al. in view of Yoshida and in further view of Kato et al.

7. GROUPING OF CLAIMS

Claims 2, 5 and 9 are grouped together and argued separately.

Claims 7-8 are grouped together and argued separately.

Claims 11-12 and 15 are grouped together and argued separately.

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Claims 17-19 are grouped together and argued separately.

All other claims stand alone and are argued separately.

8. ARGUMENT

Rejections Under 35 U.S.C. § 102

1) The Applicable Law

A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference. *M.P.E.P. ' 2131.* To anticipate a claim, a reference must disclose every element of the challenged claim and enable one skilled in the art to make the anticipating subject matter. *PPG Industries, Inc. V. Guardian Industries Corp.*, 75 F.3d 1558, 37 USPQ2d 1618 (Fed. Cir. 1996). The identical invention must be shown in as complete detail as is contained in the claim. *Richardson v. Suzuki Motor Co.*, 868 F.2d 1226, 1236, 9 USPQ2d 1913, 1920 (Fed. Cir. 1989).

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Claim 1 was rejected under 35 U.S.C. § 102(b) as being anticipated by Huang et al. (U.S. 5,719,088). This rejection is respectfully traversed.

Claim 1 includes "applying an AlN passivation layer to the top surface of the heterojunction channel field effect transistor." The Examiner suggests that Huang et al. disclose this limitation when they describe AlN layer 25. Applicant respectfully disagrees.

A passivation layer, as used in the present application, alters the electronic properties of the surface of the transistor. The function of the AlN passivation layer is to stop the uncontrolled changing of charge states at the surface during the operation of the transistor. These charge states may be due to dangling bonds, impurities, or other defects. The surface states are being controlled by this layer to be electronically passive, in contrast to being uncontrollably active.

Page 9, lines 13-15 of the application states: "One theory of the effect of surface nitrides deposited on HFETs is that the most important aspect of surface coverage is to better confine the electrical extension of the gate along the surface." The application

describes the layer as changing the electrical properties, not protecting layers below from etching.

Huang et al. indicates that layer 25 is AlN, but this is never used as a passivation layer, it is only used as an etch stop layer. As such, it is a process tool. No other functions are ascribed to it. In fact, Huang et al. indicate specifically that silicon nitride layer 22 is the passivation layer in Column 3, lines 5-15. This teaches away from having AlN function as a passivation layer. There is no stated reason to have two passivation layers.

Huang et al., also mentions a passivating film 35 that is formed at the same time that layer 22 is etched. Col. 4, lines 20-34. Thus, Huang et al. clearly distinguish an insulating layer or etch stop layer from a passivating layer. The AlN layer of Huang et al. is clearly not a passivating layer as claimed.

In the response to arguments section of the final office action, the Examiner indicates that Huang et al. refers to the AlN layer as an intermediate protective or passivation layer for layers below during an etching process. However, there is no express reference to the AlN layer as a passivation layer. While it may function to reduce "the possibility of incidental damage", it does not provide the type of passivation defined and claimed in the present application. Thus, it is not a passivation layer within the meaning of the current claims.

The Examiner states that "[s]ince the AlN etch stop layer 25 also functions as a protective layer for the layers below during the etching process as previously disclosed, it is appropriate to refer to such layer as a 'passivation layer'."

The coating described by Applicant performs a different function that is described in the application as passivation. Passivation, as used in the application is a coating that exists to alter the electronic properties of the surface of the transistor. The purpose of the AlN layer is therefore to alter the operation of the transistor for higher efficiency as a RF amplifier. As noted in the Application at page 4, lines 4-6, in one example the use of the AlN passivation surface layer approximately doubled the power output of HFETs in the 8 GHz range.

"During patent examination, the pending claims must be given the broadest reasonable interpretation consistent with the specification." *M.P.E.P.* § 2173.05(a); *In re*

Morris, 127 F.3d 1048, 1054, 44 USPQ2d 1023, 1027 (Fed. Cir. 1997); *In re Prater*, 415 F.2d 1393, 162 USPQ 541 (CCPA 1969). The AlN passivation layer disclosed in claim 1 by Applicant has a meaning distinct from the AlN layer discussed in Huang et al. and labled a passivation layer by the Examiner, and should be interpreted as such. Thus, Huang et al. do not disclose an AlN passivation layer as defined in the present application, and claim 1 should be allowed.

While the function of the AlN passivation layer in each of the pending claims should be sufficient to distinguish Huang et al., there are further structural differences. In claim 1, the passivation layer is formed on the top surface of the heterojunction channel field effect transistor, not on top of other layers as shown in Huang et al. In Huang et al., the AlN etch stop is formed on top of the actual passivation layer, not on a top surface of the transistor as claimed. Thus, it cannot accomplish the function of better confining the electrical extension of the gate along the surface.

The Examiner mentions that in FIG. 2 of Huang et al., the AlN layer 25 is formed on a top surface of the HFET. However, FIG. 2 refers to an intermediate step in the formation of the HFET. Further, the AlN layer is formed over an insulating layer 22. The Examiner indicates that the passivation layer 32 is expressly shown as an intermediate passivation layer of HFET 10 in the current application. This is not correct. Perhaps the Examiner is indicating that the airbridge is part of the HFET. This is not the case. Passivation layer 32 is clearly formed on top of the active components of the HFET.

In the Advisory Action, the Examiner states that "the features recited in claim 1 do not prevent the passivation layer from forming on top of other layers." Applicant respectfully disagrees. The passivation layer described in the specification is formed directly on top of the HFET, and not on additional layers. The specification makes it clear that the passivation layer must be directly on top of the HFET in order to alter the electronic properties of the surface of the transistor. Read in light of the specification, the claims make the structural difference between the AlN layer described by Huang et al. and the AlN layer of the current application obvious.

The Examiner indicates that the present application uses passivation layer 32 as an etch stop during the etching or patterning process of resist layer 64. This is respectfully traversed, as the application clearly states that " After forming the

passivation layer 32, photoresist is deposited and patterned to form an etch mask 64 defining windows in the passivation layer for electrical connections as illustrated in Figure 7." Page 7, lines 22-24. It is clear that the passivation layer 32 is not an etch stop. In fact, passivation layer 32 is expressly etched where not covered by the photoresist to form windows in it.

Applicant believes that claim 1 is in condition for allowance, because the reference does not disclose an AlN passivation layer being applied to the top surface of an HFET. Applicant respectfully requests the withdrawal of the rejection of claim 1.

Rejections Under 35 U.S.C. § 103

1) The Applicable Law

The Examiner has the burden under 35 U.S.C. 103 to establish a *prima facie* case of obviousness. *In re Fine*, 837 F.2d 1071, 1074, 5 USPQ2d 1596, 1598 (Fed. Cir. 1988). As part of establishing a *prima facie* case of obviousness, the Examiner must show that some objective teaching in the prior art or some knowledge generally available to one of ordinary skill in the art would lead an individual to combine the relevant teaching of the references. *Id.*

The court in *Fine* stated that:

> Obviousness is tested by "what the combined teaching of the references would have suggested to those of ordinary skill in the art." *In re Keller*, 642 F.2d 413, 425, 208 USPQ 871, 878 (CCPA 1981)). But it "cannot be established by combining the teachings of the prior art to produce the claimed invention, absent some teaching or suggestion supporting the combination." *ACS Hosp. Sys.*, 732 F.2d at 1577, 221 USPQ at 933. And "teachings of references can be combined *only* if there is some suggestion or incentive to do so."

Id. (emphasis in original).

> The M.P.E.P. adopts this line of reasoning, stating that
> "In order for the Examiner to establish a *prima facie* case of obviousness, three base criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the

prior art, and not based on Appellant s disclosure. *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed.Cir. 1991))". *M.P.E.P.* 2142

The test for obviousness under § 103 must take into consideration the invention as a whole; that is, one must consider the particular problem solved by the combination of elements that define the invention. *Interconnect Planning Corp. v. Feil*, 774 F.2d 1132, 1143, 227 USPQ 543, 551 (Fed. Cir. 1985). The Examiner must, as one of the inquiries pertinent to any obviousness inquiry under 35 U.S.C. § 103, recognize and consider not only the similarities but also the critical differences between the claimed invention and the prior art. *In re Bond*, 910 F.2d 831, 834, 15 USPQ2d 1566, 1568 (Fed. Cir. 1990), *reh'g denied*, 1990 U.S. App. LEXIS 19971 (Fed. Cir. 1990). Finally, the Examiner must avoid hindsight. *Id.*

2) Discussion of the Rejection of the Claims Under 35 U.S.C. § 103(a) as being unpatentable over Huang et al. in view of Yosida and in further view of Kato et al.

Claims 2, 5 and 9 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Huang et al. in view of Yoshida. This rejection is respectfully traversed.

The rejection of these claims is inappropriate since Huang et al. and Yoshida cannot be properly combined. Yoshida seems to be forming single crystal AlN for different purposes, such as for a semiconductor material for forming devices, forming a high hardness layer, and for use in large area surface displays. It does not address the same problems solved by the present claims, and hence is not properly combinable with Huang et al.

Additionally, Claim 2 should be allowable since is dependant upon claim 1, which is believed allowable. Claim 5 is an independent claim that distinguishes Huang et al. for at least the same reasons as claim 1. Claim 9 should be allowable since it depends from claim 5, which is now believed allowable.

Claims 2, 5 and 9 are believed to be allowable. Applicant respectfully requests the withdrawal of the rejections of claims 2, 5 and 9.

Claims 3-4 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Huang et al. in view of Kato et al. This rejection is respectfully traversed.

Claim 3 is dependant on claim 1 and is believed to be allowable for the reasons discussed above. Applicant respectfully requests the withdrawal of the rejection of claim 3.

Claim 4 was rejected by the Examiner with reference to Kato et al. While Kato et al. do mention that layer 2A is GaAs (a III-V compound), there is no teaching that AlN may be deposited in the same manner as GaAs. Most of the teaching of the application is with respect to forming II-VI compounds. FIG. 2 is also an incorrect figure. It appears to be a circuit diagram, while the application refers to it as a structural diagram of an MBE apparatus.

Claim 4 includes Al and N being applied alternately "wherein a predetermined amount of time occurs between each alternate application." The Examiner relies on Kato et al. in finding the application of alternating beams in MBE processing, and suggests that Kato et al. also disclose the predetermined delay.

The Office Action also indicates that "it should be inherent that such process comprises delaying a predetermined amount of time between each alternative application." Inherency is referenced in MPEP § 2112: "In relying upon the theory of inherency, the examiner must provide basis in fact and/or technical reasoning to reasonably support the determination that the allegedly inherent characteristic <u>necessarily</u> flows from the teachings of the applied prior art," citing <u>Ex parte Levy</u>, 17 USPQ2d 1461, 1464 (Bd. Pat. App. & Inter. 1990) (emphasis in original). The Office Action contains no assertion that delaying a predetermined amount of time necessarily flows from the description of Kato et al., other than an assumption that perhaps there is only one molecular beam source which must be switched between targets, when in fact Kato et al. specifically recites multiple such sources 37. Therefore, a prima facie case of inherency has not been established, and the rejection should be withdrawn.

Further, Kato et al. specifically refers to using the beams simultaneously. Therefore, there is no requirement that there be a time period between alternate applications of the beams, since Kato et al., is capable of operating them at the same time. In fact, inserting a delay between alternating the beams would only add to the thermal budget of the device being formed. Absent such teaching, one possible assumption is that the beams are applied alternately with no time between switching the beams.

Claim 4 is also dependant on claim 1 and allowable for the reasons argued above with respect to that claim. Applicant respectfully requests the withdrawal of the rejection of claim 4.

Claims 6-8 and 10-19 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Huang et al. in view of Yoshida and in further view of Kato et al. This rejection is respectfully traversed.

Claim 6 is dependant on claim 5. The arguments advanced with respect to claim 5 are equally applicable to claim 6. Applicant respectfully requests the withdrawal of the rejection of claim 6.

Claims 7-8 include a predetermined delay between alternating beams of Al and RF nitrogen. Claim 8 states a delay of approximately 2 seconds. This delay is similar to the delay discussed with respect to claim 4, and claims 7-8 are believed to be allowable for the same reasons. Additionally, claims 7-8 are dependant on claim 6, and believed allowable for the reasons of claim 6 as well. Applicant respectfully requests the withdrawal of the rejections of claims 7-8.

Claim 10 includes a recitation that the beams are applied at a fairly low temperature, 150°C, that is lower than that commonly used for MBE. It should also be noted that low substrate temperatures are required for post device passivation. The present method may be performed at such low temperatures. Yoshida recites temperatures of the substrate of 500°C to 1150°C at Col. 3, lines 36-37, indicating that using MBE to form AlN would not be considered for forming a passivation layer. It is not merely a design choice. The low temperature is a result of the inventive process, that allows the formation of a passivation layer that was previously unattainable. The MBE in Kato et al. is only mentioned as being performed with the substrate at a desired temperature. The art cited in this application make it clear that such a desired temperature is well above 150°C.

Claim 10 also depends from claim 5 and is allowable for the same reasons. Applicant respectfully requests the withdrawal of the rejection of claim 10.

Claims 11-12 and 15 include alternating beams of Al and remote plasma nitrogen. None of the cited references teach this method. As indicated above, Kato et al. contains no teaching that AlN may be deposited in the same manner as GaAs. Most of the

teaching of the application is with respect to forming II-VI compounds. Ratios for the VI/II compound are discussed in detail following the language about alternating beams in column 5, but there is no reference to the ratio of the GaAs compound. Therefore, it is tenuous at best that the GaAs is deposited in the same manner as the II/VI compounds. There is also no teaching in Kato et al. that AlN may be deposited in the same manner. FIG. 2 is also an incorrect figure. It appears to be a circuit diagram, while the application refers to it as a structural diagram of an MBE apparatus. Thus, the reference itself may not be enabling.

Claims 13-14 depend from claim 11 and are believed allowable. Additionally, claims 13-14 include a delay between alternating beams. This limitation is not disclosed by the references, as discussed above with respect to claim 4. Applicant respectfully requests the withdrawal of the rejections of claims 13-14.

Claim 16 depends from claim 11 and is believed allowable. Claim 16 also discloses that the beams are applied at approximately 150 degrees Celsius, as discussed above with respect to claim 10. The arguments discussed above are equally applicable to claim 16. Applicant respectfully requests the withdrawal of the rejection of claim 16.

Claims 17-19 recite using MBE at a temperature of less than approximately 300°C. As indicated above with respect to claim 10, the art references a temperature much higher than this temperature, thus teaching away from use of MBE to form an AlN layer as discussed by Applicant. Claims 17-19 also include waiting a predetermined period between applying alternate beams. As discussed with respect to claim 4, this element is also not shown in the art cited and the rejection should be withdrawn. Applicant respectfully requests the withdrawal of the rejections of claims 17-19.

9. SUMMARY

Applicant believes the claims are in condition for allowance and requests withdrawal of the rejections to claims 1-19. Reversal of the Examiner's rejections of claims 1-19 in this appeal is respectfully requested.

Respectfully submitted,

WILLIAM J. SCHAFF et al.

By their Representatives,

SCHWEGMAN, LUNDBERG,
WOESSNER & KLUTH, P.A.
P.O. Box 2938
Minneapolis, MN 55402

Date August 3, 2004 By ____________________
David W. Black
Reg. No. 42,331

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Dawn M. Poole ____________________
Name

____
Signature

APPENDIX I

The Claims on Appeal

The currently pending claims are set forth as follows:

1. (Previously Presented) A method of forming a field effect transistor, the method comprising:

forming a channel heterojunction field effect transistor having a top surface; and

applying an AlN passivation layer to the top surface of the heterojunction channel field effect transistor.

2. (Original) The method of claim 1 wherein the thickness of the AlN layer is between approximately 500 and 2000 Angstrom.

3. (Original) The method of claim 1 wherein Al and N are applied alternately until a desired thickness of AlN is obtained.

4. (Original) The method of claim 1 wherein a predetermined amount of time occurs between each alternate application.

5. (Previously Presented) A method of forming a field effect transistor, the method comprising:

forming a heterojunction channel field effect transistor having a top surface; and

applying an AlN passivation layer to the top surface of the heterojunction channel field effect transistor using molecular beam epitaxy.

6. (Previously Presented) The method of claim 5 wherein applying AlN comprises alternating beams of Al and RF nitrogen, wherein the beams are alternately applied for approximately two seconds until the desired thickness is obtained.

7. (Previously Presented) The method of claim 6 and further comprising delaying a predermined amount of time between the alternating beams.

8. (Previously Presented) The method of claim 7 wherein the beams are alternately applied for approximately two seconds, and the delay is also approximately two seconds between the alternating beams until the desired thickness is obtained.

9. (Previously Presented) The method of claim 5 wherein the AlN is applied to a desired thickness is approximately 500 Angstrom.

10. (Previously Presented) The method of claim 6 wherein the beams are applied at approximately 150 degrees Celsius.

11. (Original) A method of forming a layer of AlN of desired thickness on a semiconductor substrate, the method comprising:

using molecular beam epitaxy:

applying beams of Al; and

applying beams of remote plasma RF nitrogen alternately with the beams of AL to produce the layer of AlN of desired thickness.

12. (Original) The method of claim 11 wherein the beams are alternately applied for approximately two seconds until the desired thickness is obtained.

13. (Original) The method of claim 11 and further comprising delaying a predermined amount of time between the alternating beams.

14. (Original) The method of claim 13 wherein the beams are alternately applied for approximately two seconds, and the delay is also approximately two seconds between the alternating beams until the desired thickness is obtained.

15. (Original) The method of claim 11 wherein the desired thickness is approximately 500 Angstrom.

16. (Original) The method of claim 11 wherein the beams are applied at approximately 150 degrees Celsius.

17. (Original) A method of forming a layer of AlN of desired thickness on a semiconductor substrate, the method comprising:

using molecular beam epitaxy at a temperature less than approximately 300 degrees Celsius:

applying a beam of Al;

waiting a predetermined period;

applying a beam of remote plasma RF nitrogen;

waiting a predetermined period; and

repeating application of the beams and waiting periods to produce the layer of AlN of desired thickness.

18. (Previously Presented) The method of claim 17 wherein the desired thickness of AlN is approximately 500 Angstrom.

19. (Previously Presented) The method of claim 17 wherein the beams last approximately two seconds each application, and the waiting periods are approximately two seconds.

Claims 20-30 (Canceled).

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The AlN passivation layer in one embodiment is formed over the entire device wafer following the deposition and patterning of the interconnect metal, as shown in Figure 6 and described at page 7, lines 20-26. The deposition may be formed using molecular beam epitaxy, sputtering, or any other method which produces an approximately conformal coverage of the surface of the HFET. The deposition is preformed at approximately 150°C using alternating beams of aluminum and remote plasma RF nitrogen as discussed at page 8, lines 14-28. HFETs with the AlN passivation layer described in the current invention are useful in a wide range of products, including microwave generated plasma lights, microwave transmitters, receivers and cellular base stations to name a few.

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describes the layer as changing the electrical properties, not protecting layers below from etching.

Huang et al. indicates that layer 25 is AlN, but this is never used as a passivation layer, it is only used as an etch stop layer. As such, it is a process tool. No other functions are ascribed to it. In fact, Huang et al. indicate specifically that silicon nitride layer 22 is the passivation layer in Column 3, lines 5-15. This teaches away from having AlN function as a passivation layer. There is no stated reason to have two passivation layers.

Huang et al., also mentions a passivating film 35 that is formed at the same time that layer 22 is etched. Col. 4, lines 20-34. Thus, Huang et al. clearly distinguish an insulating layer or etch stop layer from a passivating layer. The AlN layer of Huang et al. is clearly not a passivating layer as claimed.

In the response to arguments section of the final office action, the Examiner indicates that Huang et al. refers to the AlN layer as an intermediate protective or passivation layer for layers below during an etching process. However, there is no express reference to the AlN layer as a passivation layer. While it may function to reduce "the possibility of incidental damage", it does not provide the type of passivation defined and claimed in the present application. Thus, it is not a passivation layer within the meaning of the current claims.

The Examiner states that "[s]ince the AlN etch stop layer 25 also functions as a protective layer for the layers below during the etching process as previously disclosed, it is appropriate to refer to such layer as a 'passivation layer'."

The coating described by Applicant performs a different function that is described in the application as passivation. Passivation, as used in the application is a coating that exists to alter the electronic properties of the surface of the transistor. The purpose of the AlN layer is therefore to alter the operation of the transistor for higher efficiency as a RF amplifier. As noted in the Application at page 4, lines 4-6, in one example the use of the AlN passivation surface layer approximately doubled the power output of HFETs in the 8 GHz range.

"During patent examination, the pending claims must be given the broadest reasonable interpretation consistent with the specification." *M.P.E.P.* § 2173.05(a); *In re*

Morris, 127 F.3d 1048, 1054, 44 USPQ2d 1023, 1027 (Fed. Cir. 1997); *In re Prater*, 415 F.2d 1393, 162 USPQ 541 (CCPA 1969). The AlN passivation layer disclosed in claim 1 by Applicant has a meaning distinct from the AlN layer discussed in Huang et al. and labled a passivation layer by the Examiner, and should be interpreted as such. Thus, Huang et al. do not disclose an AlN passivation layer as defined in the present application, and claim 1 should be allowed.

While the function of the AlN passivation layer in each of the pending claims should be sufficient to distinguish Huang et al., there are further structural differences. In claim 1, the passivation layer is formed on the top surface of the heterojunction channel field effect transistor, not on top of other layers as shown in Huang et al. In Huang et al., the AlN etch stop is formed on top of the actual passivation layer, not on a top surface of the transistor as claimed. Thus, it cannot accomplish the function of better confining the electrical extension of the gate along the surface.

The Examiner mentions that in FIG. 2 of Huang et al., the AlN layer 25 is formed on a top surface of the HFET. However, FIG. 2 refers to an intermediate step in the formation of the HFET. Further, the AlN layer is formed over an insulating layer 22. The Examiner indicates that the passivation layer 32 is expressly shown as an intermediate passivation layer of HFET 10 in the current application. This is not correct. Perhaps the Examiner is indicating that the airbridge is part of the HFET. This is not the case. Passivation layer 32 is clearly formed on top of the active components of the HFET.

In the Advisory Action, the Examiner states that "the features recited in claim 1 do not prevent the passivation layer from forming on top of other layers." Applicant respectfully disagrees. The passivation layer described in the specification is formed directly on top of the HFET, and not on additional layers. The specification makes it clear that the passivation layer must be directly on top of the HFET in order to alter the electronic properties of the surface of the transistor. Read in light of the specification, the claims make the structural difference between the AlN layer described by Huang et al. and the AlN layer of the current application obvious.

The Examiner indicates that the present application uses passivation layer 32 as an etch stop during the etching or patterning process of resist layer 64. This is respectfully traversed, as the application clearly states that " After forming the

passivation layer 32, photoresist is deposited and patterned to form an etch mask 64 defining windows in the passivation layer for electrical connections as illustrated in Figure 7." Page 7, lines 22-24. It is clear that the passivation layer 32 is not an etch stop. In fact, passivation layer 32 is expressly etched where not covered by the photoresist to form windows in it.

Applicant believes that claim 1 is in condition for allowance, because the reference does not disclose an AlN passivation layer being applied to the top surface of an HFET. Applicant respectfully requests the withdrawal of the rejection of claim 1.

Rejections Under 35 U.S.C. § 103

1) The Applicable Law

The Examiner has the burden under 35 U.S.C. 103 to establish a *prima facie* case of obviousness. *In re Fine*, 837 F.2d 1071, 1074, 5 USPQ2d 1596, 1598 (Fed. Cir. 1988). As part of establishing a *prima facie* case of obviousness, the Examiner must show that some objective teaching in the prior art or some knowledge generally available to one of ordinary skill in the art would lead an individual to combine the relevant teaching of the references. *Id.*

The court in *Fine* stated that:

> Obviousness is tested by "what the combined teaching of the references would have suggested to those of ordinary skill in the art." *In re Keller*, 642 F.2d 413, 425, 208 USPQ 871, 878 (CCPA 1981)). But it "cannot be established by combining the teachings of the prior art to produce the claimed invention, absent some teaching or suggestion supporting the combination." *ACS Hosp. Sys.*, 732 F.2d at 1577, 221 USPQ at 933. And "teachings of references can be combined *only* if there is some suggestion or incentive to do so."

Id. (emphasis in original).

> The M.P.E.P. adopts this line of reasoning, stating that
> "In order for the Examiner to establish a *prima facie* case of obviousness, three base criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the

prior art, and not based on Appellant s disclosure. *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed.Cir. 1991))". *M.P.E.P.* 2142

The test for obviousness under § 103 must take into consideration the invention as a whole; that is, one must consider the particular problem solved by the combination of elements that define the invention. *Interconnect Planning Corp. v. Feil*, 774 F.2d 1132, 1143, 227 USPQ 543, 551 (Fed. Cir. 1985). The Examiner must, as one of the inquiries pertinent to any obviousness inquiry under 35 U.S.C. § 103, recognize and consider not only the similarities but also the critical differences between the claimed invention and the prior art. *In re Bond*, 910 F.2d 831, 834, 15 USPQ2d 1566, 1568 (Fed. Cir. 1990), *reh'g denied*, 1990 U.S. App. LEXIS 19971 (Fed. Cir. 1990). Finally, the Examiner must avoid hindsight. *Id.*

2) Discussion of the Rejection of the Claims Under 35 U.S.C. § 103(a) as being unpatentable over Huang et al. in view of Yosida and in further view of Kato et al.

Claims 2, 5 and 9 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Huang et al. in view of Yoshida. This rejection is respectfully traversed.

The rejection of these claims is inappropriate since Huang et al. and Yoshida cannot be properly combined. Yoshida seems to be forming single crystal AlN for different purposes, such as for a semiconductor material for forming devices, forming a high hardness layer, and for use in large area surface displays. It does not address the same problems solved by the present claims, and hence is not properly combinable with Huang et al.

Additionally, Claim 2 should be allowable since is dependant upon claim 1, which is believed allowable. Claim 5 is an independent claim that distinguishes Huang et al. for at least the same reasons as claim 1. Claim 9 should be allowable since it depends from claim 5, which is now believed allowable.

Claims 2, 5 and 9 are believed to be allowable. Applicant respectfully requests the withdrawal of the rejections of claims 2, 5 and 9.

Claims 3-4 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Huang et al. in view of Kato et al. This rejection is respectfully traversed.

Claim 3 is dependant on claim 1 and is believed to be allowable for the reasons discussed above. Applicant respectfully requests the withdrawal of the rejection of claim 3.

Claim 4 was rejected by the Examiner with reference to Kato et al. While Kato et al. do mention that layer 2A is GaAs (a III-V compound), there is no teaching that AlN may be deposited in the same manner as GaAs. Most of the teaching of the application is with respect to forming II-VI compounds. FIG. 2 is also an incorrect figure. It appears to be a circuit diagram, while the application refers to it as a structural diagram of an MBE apparatus.

Claim 4 includes Al and N being applied alternately "wherein a predetermined amount of time occurs between each alternate application." The Examiner relies on Kato et al. in finding the application of alternating beams in MBE processing, and suggests that Kato et al. also disclose the predetermined delay.

The Office Action also indicates that "it should be inherent that such process comprises delaying a predetermined amount of time between each alternative application." Inherency is referenced in MPEP § 2112: "In relying upon the theory of inherency, the examiner must provide basis in fact and/or technical reasoning to reasonably support the determination that the allegedly inherent characteristic <u>necessarily</u> flows from the teachings of the applied prior art," citing <u>Ex parte Levy</u>, 17 USPQ2d 1461, 1464 (Bd. Pat. App. & Inter. 1990) (emphasis in original). The Office Action contains no assertion that delaying a predetermined amount of time necessarily flows from the description of Kato et al., other than an assumption that perhaps there is only one molecular beam source which must be switched between targets, when in fact Kato et al. specifically recites multiple such sources 37. Therefore, a prima facie case of inherency has not been established, and the rejection should be withdrawn.

Further, Kato et al. specifically refers to using the beams simultaneously. Therefore, there is no requirement that there be a time period between alternate applications of the beams, since Kato et al., is capable of operating them at the same time. In fact, inserting a delay between alternating the beams would only add to the thermal budget of the device being formed. Absent such teaching, one possible assumption is that the beams are applied alternately with no time between switching the beams.

Claim 4 is also dependant on claim 1 and allowable for the reasons argued above with respect to that claim. Applicant respectfully requests the withdrawal of the rejection of claim 4.

Claims 6-8 and 10-19 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Huang et al. in view of Yoshida and in further view of Kato et al. This rejection is respectfully traversed.

Claim 6 is dependant on claim 5. The arguments advanced with respect to claim 5 are equally applicable to claim 6. Applicant respectfully requests the withdrawal of the rejection of claim 6.

Claims 7-8 include a predetermined delay between alternating beams of Al and RF nitrogen. Claim 8 states a delay of approximately 2 seconds. This delay is similar to the delay discussed with respect to claim 4, and claims 7-8 are believed to be allowable for the same reasons. Additionally, claims 7-8 are dependant on claim 6, and believed allowable for the reasons of claim 6 as well. Applicant respectfully requests the withdrawal of the rejections of claims 7-8.

Claim 10 includes a recitation that the beams are applied at a fairly low temperature, 150°C, that is lower than that commonly used for MBE. It should also be noted that low substrate temperatures are required for post device passivation. The present method may be performed at such low temperatures. Yoshida recites temperatures of the substrate of 500°C to 1150°C at Col. 3, lines 36-37, indicating that using MBE to form AlN would not be considered for forming a passivation layer. It is not merely a design choice. The low temperature is a result of the inventive process, that allows the formation of a passivation layer that was previously unattainable. The MBE in Kato et al. is only mentioned as being performed with the substrate at a desired temperature. The art cited in this application make it clear that such a desired temperature is well above 150°C.

Claim 10 also depends from claim 5 and is allowable for the same reasons. Applicant respectfully requests the withdrawal of the rejection of claim 10.

Claims 11-12 and 15 include alternating beams of Al and remote plasma nitrogen. None of the cited references teach this method. As indicated above, Kato et al. contains no teaching that AlN may be deposited in the same manner as GaAs. Most of the

teaching of the application is with respect to forming II-VI compounds. Ratios for the VI/II compound are discussed in detail following the language about alternating beams in column 5, but there is no reference to the ratio of the GaAs compound. Therefore, it is tenuous at best that the GaAs is deposited in the same manner as the II/VI compounds. There is also no teaching in Kato et al. that AlN may be deposited in the same manner. FIG. 2 is also an incorrect figure. It appears to be a circuit diagram, while the application refers to it as a structural diagram of an MBE apparatus. Thus, the reference itself may not be enabling.

Claims 13-14 depend from claim 11 and are believed allowable. Additionally, claims 13-14 include a delay between alternating beams. This limitation is not disclosed by the references, as discussed above with respect to claim 4. Applicant respectfully requests the withdrawal of the rejections of claims 13-14.

Claim 16 depends from claim 11 and is believed allowable. Claim 16 also discloses that the beams are applied at approximately 150 degrees Celsius, as discussed above with respect to claim 10. The arguments discussed above are equally applicable to claim 16. Applicant respectfully requests the withdrawal of the rejection of claim 16.

Claims 17-19 recite using MBE at a temperature of less than approximately 300°C. As indicated above with respect to claim 10, the art references a temperature much higher than this temperature, thus teaching away from use of MBE to form an AlN layer as discussed by Applicant. Claims 17-19 also include waiting a predetermined period between applying alternate beams. As discussed with respect to claim 4, this element is also not shown in the art cited and the rejection should be withdrawn. Applicant respectfully requests the withdrawal of the rejections of claims 17-19.

APPENDIX I

The Claims on Appeal

The currently pending claims are set forth as follows:

1. (Previously Presented) A method of forming a field effect transistor, the method comprising:

forming a channel heterojunction field effect transistor having a top surface; and

applying an AlN passivation layer to the top surface of the heterojunction channel field effect transistor.

2. (Original) The method of claim 1 wherein the thickness of the AlN layer is between approximately 500 and 2000 Angstrom.

3. (Original) The method of claim 1 wherein Al and N are applied alternately until a desired thickness of AlN is obtained.

4. (Original) The method of claim 1 wherein a predetermined amount of time occurs between each alternate application.

5. (Previously Presented) A method of forming a field effect transistor, the method comprising:

forming a heterojunction channel field effect transistor having a top surface; and

applying an AlN passivation layer to the top surface of the heterojunction channel field effect transistor using molecular beam epitaxy.

6. (Previously Presented) The method of claim 5 wherein applying AlN comprises alternating beams of Al and RF nitrogen, wherein the beams are alternately applied for approximately two seconds until the desired thickness is obtained.

7. (Previously Presented) The method of claim 6 and further comprising delaying a predermined amount of time between the alternating beams.

8. (Previously Presented) The method of claim 7 wherein the beams are alternately applied for approximately two seconds, and the delay is also approximately two seconds between the alternating beams until the desired thickness is obtained.

9. (Previously Presented) The method of claim 5 wherein the AlN is applied to a desired thickness is approximately 500 Angstrom.

10. (Previously Presented) The method of claim 6 wherein the beams are applied at approximately 150 degrees Celsius.

11. (Original) A method of forming a layer of AlN of desired thickness on a semiconductor substrate, the method comprising:

using molecular beam epitaxy:

applying beams of Al; and

applying beams of remote plasma RF nitrogen alternately with the beams of AL to produce the layer of AlN of desired thickness.

12. (Original) The method of claim 11 wherein the beams are alternately applied for approximately two seconds until the desired thickness is obtained.

13. (Original) The method of claim 11 and further comprising delaying a predermined amount of time between the alternating beams.

14. (Original) The method of claim 13 wherein the beams are alternately applied for approximately two seconds, and the delay is also approximately two seconds between the alternating beams until the desired thickness is obtained.

15. (Original) The method of claim 11 wherein the desired thickness is approximately 500 Angstrom.

16. (Original) The method of claim 11 wherein the beams are applied at approximately 150 degrees Celsius.

17. (Original) A method of forming a layer of AlN of desired thickness on a semiconductor substrate, the method comprising:

using molecular beam epitaxy at a temperature less than approximately 300 degrees Celsius:

applying a beam of Al;

waiting a predetermined period;

applying a beam of remote plasma RF nitrogen;

waiting a predetermined period; and

repeating application of the beams and waiting periods to produce the layer of AlN of desired thickness.

18. (Previously Presented) The method of claim 17 wherein the desired thickness of AlN is approximately 500 Angstrom.

19. (Previously Presented) The method of claim 17 wherein the beams last approximately two seconds each application, and the waiting periods are approximately two seconds.

Claims 20-30 (Canceled).